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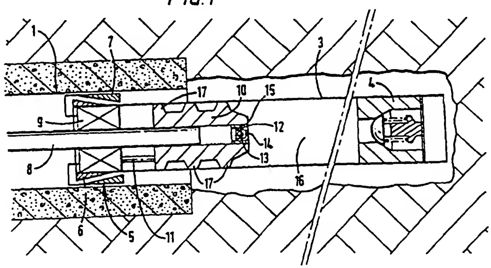
(54) Abstract Title
Liner assembly and method of running the same

(57) A liner assembly for a wellbore comprises a liner 3, a non-return valve 4 at or adjacent the downstream end thereof, a liner hanger assembly 5 at or adjacent the upstream end of the liner 3, a running tool releasably connected to the liner hanger assembly 5, and a plug 10 at or adjacent the upstream end of the liner 3 and defining with the non-return valve 4 and liner 3 an isolated space 16, the plug 10 having a unit 13, 14 which can be acted upon to allow fluid into said isolated space. Accordingly, a method of running the above disclosed liner assembly comprises floating the liner 3 into the wellbore, pumping fluid into the plug 10 to cause the unit to fail and then pumping fluid through the liner 3 and back through the annular space between the liner 3 and the wellbore to condition the space therebetween, pumping cement through the plug 10 and down the liner 3, and obstructing the plug 10, for example with a dart, and pumping the plug 10 down the liner 3 to urge the cement down the liner and into the wellbore annulus.

FIG.1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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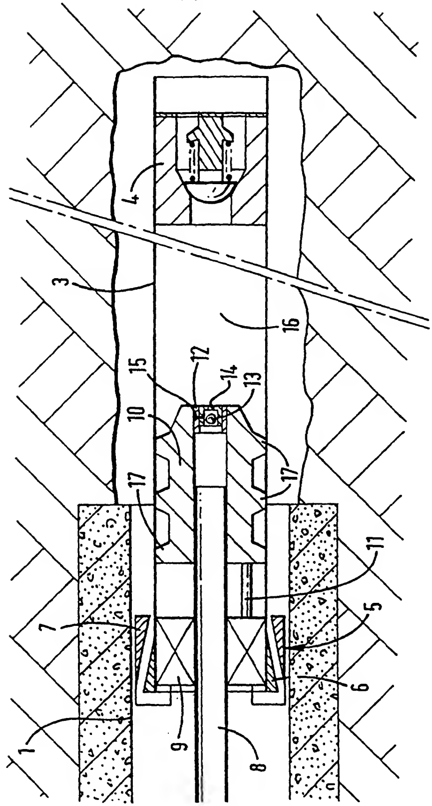

FIG.1

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Liner Assembly and Method of Running the same

This invention relates to a liner assembly and to a method of running the same.

During the construction of oil and gas wells it is becoming increasingly common to provide a main wellbore with one or more long, nearly horizontal boreholes. A liner is subsequently introduced into these boreholes and is then cemented in place.

Whilst it is relatively easy to lower a liner down a vertical borehole it is relatively difficult to introduce a liner into a horizontal borehole. As a result, near horizontal boreholes, which can be up to 14km in length, tend to be provided with a succession of liners of progressively smaller diameter. This is a time consuming and expensive operation and various methods and apparatus have been proposed for reducing the number of liners which have to be used to line a long, near horizontal, wellbore.

Such solutions include the use of low friction centralizers and the use wellbore tractors which are designed to craw along a borehole dragging a liner behind them. Another solution involves sealing the liner so that a volume of air is trapped in the liner and 'floating' the liner into position in drilling mud in the wellbore. This is a very promising technique which involves the use of various pieces of equipment to trap the air in the liner. Such equipment typically includes a downstream float collar which extends across the liner at or adjacent the downstream end thereof and an upstream flotation collar which is shear pinned to the liner, typically 3000m upstream of the float collar.

In use, the liner is lowered down the wellbore through existing casing and manoeuvred into position on the downstream end of a workstring. Once the liner is in position the workstring is withdrawn. Conditioning fluid

is then pumped down the casing and the pressure is raised until a diaphragm in the floatation collar ruptures. The conditioning fluid then passes through the liner and the downstream float collar and returns in the annular space between the liner and the borehole. Once the annular space has been conditioned a bottom plug is introduced into the casing and pumped down with the required volume of cement. A top plug is then inserted into the casing above the cement and the bottom plug, cement and top plug are pumped down the casing, typically using drilling mud.

When the bottom plug lands on the flotation collar the pressure is increased until the shear pins securing it to the liner fail and the flotation collar precedes the bottom plug to the float collar. When the flotation collar, bottom plug, cement and top plug are resting on the float collar pressure is applied to the top plug to rupture a bursting disk in the bottom plug. This allows the cement to pass through the float collar, around the bottom of the casing and into the annular space circumjacent the liner until the top plug lands on the bottom plug. The liner is then pressure tested and the cement allowed to set. After this, the top plug, bottom plug, flotation collar, float collar and cement remaining in the liner beneath the float collar are drilled out before the wellbore is extended.

One of the difficulties which the Applicants have experienced is that after the shear pins have been fractured the flotation collar can become jammed in the liner long before landing on the float collar. As pressure is increased to attempt to free the float collar the bursting disk in the bottom plug ruptures resulting in the cement flowing into the liner beneath the jammed flotation collar. If the flotation collar cannot be moved after the top plug has landed the cement sets in the liner and must subsequently be drilled out. Such

drilling out can involve the removal of as much as 2000m of cement and is thus most unwelcome.

The applicants believe that this problem can be addressed by a radical change in the design of the flotation collar. In particular, present flotation collars are of relatively short axial length and have a steel body which is a close fit with the inside of th liner, sealing being achieved with an o-ring. In addition they are secured to the liner by several short shear pins. The present invention is based on the concept of replace the known flotation collar with a modified plug. Plugs have been used for many years and are extremely reliable in so far as it is extremely rare for present day plugs to become jammed whilst travelling down a tubular.

The present invention provides a liner assembly which comprises:

(a) a liner;

(b) a non-return valve at or adjacent the downstream end of said liner;

(c) a liner hanger assembly at or adjacent the upstream end of said liner;

(d) a running tool releasably connected to said liner hanger assembly; and

(e) a plug at or adjacent the upstream end of said liner and defining with said non-return valve and said liner an isolated space, said plug having a unit which can be acted upon to allow fluid to pass into said isolated space.

Preferably, said non-return valve comprises a float shoe or a float collar.

Advantageously, said unit comprises a ball and a seat.

Preferably, said plug is connected to said running tool by a shear member.

Advantageously, said liner assembly includes a workstring.

The present invention also provides a method of running a liner in accordance with the present invention, which method comprises the steps of:

(a) 'floating' said liner into a wellbore,

(b) pumping fluid into said plug to cause said unit to fail and then pumping fluid through said liner and back through the annular space between said liner and said wellbore to condition the space therebetween,

(c) pumping cement through said plug and down said liner, and

(d) obstructing said plug, for example with a dart or ball, and pumping said plug down said liner to urge said cement down said liner.

For a better understanding of the present invention reference will now be made, by way of example, to the accompanying drawing, in which:

Fig. 1 is a schematic cross-section showing one embodiment of an apparatus in accordance with the present invention in use.

Referring to the Fig. 1 there is a shown a length of casing 1 which is cemented in a near horizontal borehole 2.

A liner 3, which is about 3000m in length, extends from the casing 1. The downstream end of the liner 3 is provided with a float collar 4 whilst the upstream end of the liner 3 is fitted with a liner hanger assembly 5 which is schematically illustrated by a first series of radially spaced wedges 6 fixed to the outer surface of the upstream end of the liner 3 and a corresponding series of radially spaced movable wedges 7 which are axially aligned with the wedges 6.

The liner 3 is releasably connected to a workstring 8 by means of a running tool 9 which is fast with the workstring 8.

A plug 10 is slidably mounted on the downstream end of the workstring 8 and is attached to the running tool 9 by a shear member 11.

The downstream end of the plug 10 is formed with an integral section 12 of reduced diameter and a unit comprising a ball 13 and a seat 14 which is attached to the integral section 12 by a shear pin 15.

After the borehole has been drilled the liner 3 is lower down the wellbore with the float collar 4 fitted at or near the downstream end of the liner 3. If desired, a second float collar may be provided near the float collar 4 as a safety measure.

When the desired length or liner 3 has been lowered into the wellbore the liner hanger assembly 5 is

secured to the liner 3 and the plug 10 and running tool 9 are inserted into the wellbore and lowered on the workstring 8.

As the liner 3 is lowered the workstring 8 is filled with circulating fluid to provide additional thrust to urge the liner 3 into the near horizontal borehole 2.

The float collar 4, the liner 3 and the plug 10 together define an isolated volume 16 which is filled with air. This help the liner 3 to be 'floated' into position in the drilling mud in the near horizontal borehole 2.

When the liner 3 reaches its desired position the pressure of the circulating fluid is increased. This causes the running tool 9 to move the movable wedges 7 into engagement with the wedges 6. As the movable wedges 7 engage the wedges 6 they move outwardly and engage the casing to 'set' the liner hanger assembly 5.

Once the liner hanger assembly 5 is set the pressure of the circulating fluid is increased to shear the shear pin 15. The unit comprising the ball 13 and the seat 14 is then flushed downstream by the conditioning fluid which subsequently flows through the float collar 4 and returns through the annulus between the liner 3 and the near horizontal borehole 2 thus conditioning it for cementing.

Cement is then pumped down the workstring 8. When the desired quantity of cement has been dispatched a dart is inserted into the workstring and pumped down by drilling mud. As the dart passes down the workstring 8 it wipes the inner surface of the tubulars and eventually lands on the integral section 12 of the plug 10. The pressure is then increased until the shear member 11 fractures thus releasing the plug 10 and the dart which together form a top plug which pumps the cement down the liner 3 until the plug 10 lands on the float collar 4.

It should be noted that the plug 10 is similar in certain respects to the tried and tested top plugs, bottom plugs and wiper plugs used in cementing operations. In particular it is relatively long and comprises fins 17 which are relatively resilient. By its radically different construction from present day flotation collars it is unlikely to become jammed as it passes down the liner 3.

Although it is conceivable that the plug 10 could be shear pinned to the liner 3 this is not recommended since it would be difficult to provide a reliable shear pin structure. In contrast, it is extremely easy to provide the shear member 11 between the plug 10 and the running tool 9.

Various modifications to the embodiment describer are envisaged. For example the ball 13 and seat 14 could be replaced by a bursting disk. The plug 10 could be associated with a second plug slidably mounted on the workstring 8 upstream of the plug 10. Such an arrangement might be used where it is desirable to provide maximum protection to the cement from contamination, for example where the conditioning fluid is particularly corrosive. Alternatively, such a plug might be used as a wiper to remove traces of cement from the wall of the liner after cementation.

It will be noted that the liner 3 can be run and cemented in a single trip - thus saving considerable time and cost.

CLAIMS:

1. A liner assembly which comprises:

(a) a liner (3);

(b) a non-return valve (4) at or adjacent the downstream end of said liner (3);

(c) a liner hanger assembly (5) at or adjacent the upstream end of said liner (3);

(d) a running tool (9) releasably connected to said liner hanger assembly (5); and

(e) a plug (10) at or adjacent the upstream end of said liner (3) and defining with said non-return valve (4) and said liner (3) an isolated space (16), said plug (10) having a unit (13,14) which can be acted upon to allow fluid to pass into said isolated space (16).

2. A liner assembly as claimed in Claim 1, wherein said non-return valve comprises a float shoe or a float collar (4).

3. A liner assembly as claimed in Claim 1 or 2, wherein said unit comprises a ball (12) and a seat (14).

4. A liner assembly as claimed in Claim 1, 2 or 3, wherein said plug (10) is connected to said running tool (9) by a shear member (11).

5. A liner assembly as claimed in any preceding Claim, including a workstring.

6. A method of running a liner as claimed in Claim 1, which method comprises the steps of:

(a) 'floating' said liner into a wellbore,

(b) pumping fluid into said plug (10) to cause said unit to fail and then pumping fluid through said liner (3) and back through the annular space between said liner (3) and said wellbore (2) to condition the space therebetween,

(c) pumping cement through said plug (10) and down said liner (3), and

(d) obstructing said plug (10), for example with a dart, and pumping said plug (10) down said liner to urge said

cement down said liner (3).